# CS 124 Programming Assignment 2: Spring 2022

**Your name(s) (up to two):** Burak Ufuktepe

**Collaborators:** None

No. of late days used on previous psets: 10

No. of late days used after including this pset:

## Analytical Approach

Let and be the time required to multiply two matrices using the conventional matrix multiplication algorithm and Strassen’s algorithm, respectively.

Let be the time required to multiply two matrices using the conventional matrix multiplication algorithm. The conventional matrix multiplication requires multiplications and additions for each element and there are elements in the matrix. Therefore, the runtime for the conventional matrix multiplication is:

Let be the time required to multiply two matrices using Strassen’s algorithm. Strassen’s algorithm performs 7 multiplications and 18 additions/subtractions of matrices of size . The reason why we use a ceiling function is because needs to be divided in half evenly, if is odd we would need to pad the matrix with one extra zero row and one extra zero column. Thus, we can express the recurrence relation as follows:

To find the cross-over point we need to find the value for when . So, we can simply use the equality and solve for .

If is even, we have:

This shows when is even and less than 15, switching to the conventional algorithm will be more optimal than using Strassen’s algorithm.

If is odd, we will have to pad the matrices with one extra zero row and one extra zero column. Let . After padding the matrices and dividing by half we obtain:

So we have:

This shows when is odd and less than 37.2, switching to the conventional algorithm will be more optimal than using Strassen’s algorithm.

## Optimizations

### Data Layout

Splitting matrices takes up a significant portion of the actual runtime in Strassen’s algorithm. To speed up this process, instead of using a standard row-major ordering, Morton ordering is used to represent matrices. Morton ordering arranges the matrix in block arrays where is the size of the “base case”.

This way each quadrant is stored contiguously in memory.

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